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INDEX NUMBERS OF PRICES.

The following article is a reprint of a "Memorandum on the Construction of Index Numbers of Prices," prepared by Mr. Fountain for the "Report on Wholesale and Retail Prices in the United Kingdom, in 1902, with Comparative Statistical Tables for a Series of Years," recently published by the Board of Trade of England.

Introduction.—In 1887 a committee of experts appointed by the British Association for the Advancement of Science to report on the best methods of measuring changes in the value of the monetary standard produced its first report. Subsequent reports were issued in 1888, 1889, and 1890. In preparing the following Memorandum, I am largely indebted to these reports and to various memoranda attached to them, especially that of Professor Edgeworth, published with the 1887 report.

I have, however, in all cases consulted the original papers and volumes referred to below.

My aim has been to touch on all the principal questions which arise in the practical construction of an Index Number, not to discuss all the forms which such a number may theoretically assume.

Some confusion occasionally arises from the different senses in which the term "Index Number" is used: I have applied it only to the numbers which measure the average price variation of a number of commodities. The word "weight" is used for the extent to which price variations in particular commodities are allowed to affect this average.

In note A will be found a list of the principal authorities consulted.

Two Methods of Approaching the Subject.—The method of Index Numbers has been suggested or employed by persons regarding the phenomena of prices from two different standpoints. The first, or theoretical, point of view is closely bound up with the so-called "Quantity Theory" of Money. The object of this group of investigators is in general to obtain some measure of the changes in prices due to changes in the quantity in circulation of the precious metal or metals constituting the monetary standard of any country for the time being. Jevons, for instance, who appears to have been the first to employ the method, or at least the first to elevate it to the rank of a scientific method, adopted it with the object of ascertaining the effect on prices of the great gold discoveries. The second or practical point of view has for its object the obtaining of some measure of the change in the

purchasing power of money between two periods of time. For those who make use of the method from this point of view no theory as to the source of those changes is involved. It is apparent that there is considerable difference in the amount of the commodities that can be obtained, whether in the large markets or by the retail consumer, for a certain quantity of gold at the two epochs; and it is desired to measure this difference.

The Investigation of Jevons.—The work of Jevons in this subject is contained in an essay published in 1863, under the title of “A Serious Fall in the Value of Gold Ascertained,” and a paper “On the Variations of Prices and the Value of the Currency since 1782,” read before the Statistical Society and published in 1865, both of which have been subsequently included in the volume published in 1884 under the title “Investigations in Currency and Finance.”

In the first of these essays he endeavors to trace the effect of the gold discoveries by comparing the average changes in the prices of a number of commodities between the group of years 1845–50 and the group 1860–62. For this purpose he takes the average market prices of each of 39 articles in each period, and expresses the second set of prices in the form of percentages of the first.* He then (by the method of logarithms) takes the geometric mean of these percentages. In the second paper he deduces an index number for each year from 1782 to 1865.

His Employment of the Geometric Mean.—His employment of the geometric mean shows at once that Jevons is not attempting so much to measure directly the change in the actual purchasing power in use of money as a change in something lying below all the particular changes in the prices of particular commodities. His object is, in fact, to eliminate the variations peculiar to particular commodities in order to reach an underlying variation common to all. From his point of view I do not think the use of the geometric mean in preference to the arithmetic can be seriously criticised. His argument is as follows:—

“Any change in gold will affect all prices in an equal ratio, and, if other disturbing causes may be considered proportional to the ratio of change of price they produce in one or more commodities, then all the individual variations in price will be correctly balanced”—by the use of the geometric mean.

* It should be stated that in addition to employing 39 principal articles he also works out some of his results for a considerably larger number of supplementary articles. Although the results are somewhat different, there is no difference in the method employed. For the results of his calculation see Note C, p. 450.

Thus, for instance, a plentiful harvest halving the price of one commodity may be balanced against a scarce harvest doubling the price of another (I have purposely taken an extreme instance), and the only way of securing that this is so is by making use of the geometric mean. If prices of two commodities are raised from 100 to 200 and lowered from 100 to 50 respectively, the changes may be balanced one against another. This involves the use of the geometric instead of the arithmetic mean.

The Unweighted Mean.—Jevons's method of approaching the subject implies not only the use of the geometric mean, but the use of an unweighted mean. In his system, in fact, all commodities are regarded as of equal importance. If the object aimed at is not to obtain directly a measure of the practical purchasing power of gold, but rather to express the general tendency in price underlying all prices, then the changes in the value of palm oil or pepper may be as useful for the purpose as the change in the value of cotton.

This last statement is, however, subject to certain qualifications. In the first place it would appear that the prices of certain commodities respond more directly to currency causes. Professor Kraemar, for instance, in his work on the history of paper money in Austria, has shown that the fluctuations in the prices of certain commodities corresponded more directly with the fluctuations in the premium than was the case with other commodities. Professor Jevons tried the experiment of omitting commodities which showed disproportionately large variations, and also of weighting commodities inversely as the range between the highest and lowest prices, without, however, getting sensibly different results.

The second consideration is that adduced by Professor Edgeworth, that, as both market prices and declared values represent not single prices, but averages more or less exact, the commodities in which the transactions are greatest are those for which the prices are most reliable, and that therefore even on Jevons's hypothesis there is something to be said for counting the commodities a number of times varying with their relative importance in trade. Jevons himself appears to have had some such idea when he allowed for the importance of certain commodities by quoting several varieties.

In spite, however, of this consideration, we must regard the typical Index Number prepared from this point of view as an unweighted geometric mean of the ratio of the changes in price between two periods of a large number of commodities. Leaving on one side for the moment the question of weighting, attention may be called to the fact that the question of the selection of a mean has a greater

practical effect than might perhaps be imagined. Thus Jevons's calculation, based on 39 principal articles, goes to show that as between the years 1845-50 and 1860-62 prices rose by 16.2 per cent. If, however, we take the arithmetic mean instead of the geometric of the price variations used by Jevons, the rise in prices works out as 18 per cent.

The Consumption Standard.—It may be doubted, having regard—amongst other considerations—to the very different sensitiveness to currency changes of different commodities,* whether a random selection of commodities can give any result capable of interpretation. We turn therefore to the Index Numbers which are approached from a more “objective” and practical standpoint. The problem for solution may, in fact, be stated generally as follows: How to obtain a measure of the practical effect of all the changes in prices which have taken place within a certain period? The most usual answer to this question is that which appeals to a “consumption standard,” and the greater part of this memorandum will be taken up with the discussion of such a standard.

The theoretical basis of the consumption standard is the proposition that the true measure in the change of the value of money is the change in the amount of gold that must be paid by consumers throughout the country for all commodities in their finished state consumed by them per unit of time. In practice, of course, the only method of approximating to this ideal measure is the method of sample. No trustworthy figures being available for the retail prices of the commodities actually consumed, it is usual to take certain raw materials as typical of these commodities and to assume that, roughly speaking, the changes in the prices of these raw materials, although possibly more rapid and violent than the changes in prices of the manufactured articles consumed, do on the whole, over relatively long periods of time, afford a fair measure of these changes.

It is essential to the soundness of this calculation that no commodity should be weighted at too high a figure, owing to its appearing in different forms in different commodities. Thus, if we decide to take pig-iron as representative of all iron goods, and allow it a weight in the calculation proportional to the value consumed, we must not allow coal its full weight without deducting the coal used in the manufacture of pig-iron.

In saying that pig-iron may be taken as representative of all iron goods, I do not forget that much of the iron that enters into consump-

*In this connection reference may be made to the discussion on the so-called “precession” of prices in Mr. A. Delmar's “Science of Money.”

tion does so in a form which makes the actual cost of the raw material of slight importance. The value of a watch-spring, for instance, is hardly affected by considerable fluctuations in the cost of pig-iron. Even in these extreme cases, however, the cost of the pig-iron does affect the cost of the spring,—not in proportion, indeed, to the value of the spring, but in proportion to the value of the iron used in its manufacture. This obvious truth appears to have been forgotten by those who, in devising a system of weights, have attempted to make some allowance for the increase in the value of a raw material before its entry into consumption. This increase is due, not to any inherent quality in the article itself, but to the consumption of other articles, such as labor and coal in the process of changing it; and changes in the price of these supplementary commodities will, to a great extent, be allowed for in other constituent elements of the Index Number itself.

The Inclusion of Rent, Professional Services, etc.—It would seem, then, that an ideal consumption Index Number should not only contain all actual materials in a raw state, but should contain figures representing the labor used in working them up. It has sometimes been suggested that rent, professional, intellectual, and even artistic services, should find a place in any Index Number that represents the consumption of a nation.

The only answer to this contention is, I fear, that it is impossible to include them. So far, indeed, as rent represents money paid for the actual use of the bricks, mortar, timber, etc., it may well be represented by the raw materials of building. That part of rent which measures the advantage of living in one spot rather than another must, I think, in any case, be left out of count, together with the cost of professional services, etc. We are, at the outset, confronted with the fact that this advantage and these services do not admit of standardizing. Even if it were possible to compare the amounts of money paid for them by the public in different years, yet no comparison is possible, as in the case of measurable commodities, between the goods obtained in exchange.

Professor Nicholson's Criticism of the Employment of Wholesale Prices of Raw Materials.—The system of treating raw materials as typical of all articles consumed has been criticised by Professor Nicholson, who has an entirely distinct method of his own. He argues that wholesale prices of raw materials are an unsatisfactory index of general prices because "the improvement in efficiency of labor has been much more marked over any considerable period in other industries than in the extractive and agricultural group.

Skilled labor obtains higher nominal wages reckoned in time, but produces more cheaply. The rise in skilled labor, however, has raised proportionately the wages of unskilled labor, in which the increase in efficiency has not been so great."

In other words, it is argued that the price of the finished article should fall (in a time of falling prices) to a greater extent than that of raw materials. This appears to neglect the question of transport. For, if economies in manufacture have increased, economies in transport have been at least as important. And the cost of transport affects raw commodities much more in proportion to their value than it does the relatively higher-priced finished article. If the price of each were to be always taken at the place of production, which is for many reasons desirable, but, unfortunately, in practice impossible, there might be something in the contention, which, as it is, does not appear to be borne out by the facts. For instance, the British exports may roughly be said to represent finished articles as compared with the imports; and it is shown in Sir Robert Giffen's reports to the Board of Trade on the prices of imports and exports that the prices of the former had, between 1861 and 1886, fallen considerably less than those of the latter. The Index Number for exports fell from 65.8 in 1861 to 53.4 in 1886, whilst the Index Number for imports fell in the same period from 81.6 to 60.2. Indeed, it is probably more true to say that the prices of finished articles rise less than those of raw materials when the latter are rising, and fall less when they are falling. This is, perhaps, in part due to the stability of money wages being greater than that of prices of raw materials.

Considerations such as these, whilst they impair the exactness of any deductions made from Index Numbers, do not detract from the general conclusions deduced from the quite considerable movement of these numbers. They do, however, suggest the question whether there is any utility in devising an exact system of weighting, having regard to the necessarily rough character of the results.

The Necessity of Weighting.—It is certainly the case that the best known Index Numbers, and those which have been most extensively made use of, are not weighted at all according to any exact principle. It is, in fact, found in practice that the main bulk of wholesale prices does as a rule move in much the same direction, although at varying rates. Thus it is that, except under abnormal circumstances, the general tendency of the curves traced out by the various Index Numbers in ordinary use is much the same. Sir Robert Giffen in his evidence before the Gold and Silver Commission states it as his opinion that the absence of weighting in Jevons's calculations is, for this reason, of no great importance.

Laspeyres, too, in his paper in the *Jahrbuch für Nationalökonomie* for 1871,* considers that, having regard to the doubts introduced by doubtful price quotations, the slight difference between the weighted and unweighted mean is not of sufficient practical importance to justify the additional trouble involved in making use of the former. Again, in the reports on the prices of imports and exports, elsewhere referred to, a large number of systems of weighting are given; but it is found that the practical effect of adopting one rather than the other is very slight. In fact, in normal years, when nothing of an exceptional character occurs to affect to any great extent the general level of prices, the adoption of a scientific system of weighting is desirable rather for the purpose of anticipating theoretical criticism than because of the practical difference in the result. When, however, the general trend of prices is interrupted violently by circumstances of a special character,—as was the case, for example, in the years 1871–73, when prices which had been slowly falling rose violently, argely on account of the Franco-Prussian War,—certain articles are often more affected than others, and the weighting of the prices may have an appreciable effect on the result. Of course, this is all the more noticeable when circumstances of a special character occur affecting directly the price of one particular article. Thus Sir Robert Giffen notes in his evidence before the Gold and Silver Commission that, during the American war, the Index Number of Jevons, in which cotton appears in 3 out of the 39 articles, shows less rise than does the *Economist* Index Number, in which cotton appears in 4 out of 22 articles. In Note B on pp. 448–449 I have illustrated at greater length both the slightness of the effect of weighting under normal conditions, and the difference that may be due to it in an abnormal period.

The “Economist” Index Number.—The *Economist* Index Number, to which I have referred above, has the following history: In 1859, William Newmarch, then the editor of the *Journal of the Statistical Society*, published a paper in that journal on the prices of the previous year. In this article the prices of 19 commodities in the London markets were expressed as percentages of the average prices of 1845–50. These commodities were as follows: coffee, sugar, tea, tobacco, wheat, butchers’ meat, cotton, silk, flax and hemp (average), wool, indigo, oils (average of three varieties), timber, tallow, leather, copper, iron, lead, tin. In 1860 and 1861 similar articles appeared in the journal,

*Entitled “Die Berechnung einer mittlerer Waarenpreissteigerung.” The paper was in answer to the criticisms of Drobisch on his previous paper of 1864, entitled “Hamburger Waarenpreise.”

when in addition to these 19 commodities three others were added,—namely, raw cotton, cotton yarn, and cotton cloth,—all at Manchester prices. The prices of each of these 22 commodities were expressed in the form of percentages, but no Index Number was constructed from them. These commodities and the method of proportional prices were adopted by the *Economist* in its Annual Commercial History first published in 1864. It was not until 1869 that the numbers were added together, and thus became the *Economist* Index Number, which has been published year by year ever since that date. It will be seen that, in this Index Number, cotton practically has a weight of four, whilst other commodities—wheat and indigo alike—are only weighted as one.

Mr. Sauerbeck's Index Number.—The method of rough weighting by quoting either several varieties of the same article or the same article in different stages of manufacture was adopted by Mr. Sauerbeck in his classical paper published in 1886 in the *Journal of the Statistical Society*. It is true that he also worked out certain results with an Index Number weighted according to the National Consumption, but he appears to have been of the opinion that this was a needless refinement, and the Index Number usually known by his name is the so-called unweighted Index Number. As this number is one of those most quoted, I give here the 45 articles or heads on which it is based, with the prices for 1885, these prices being the average of market prices taken monthly throughout the year, and being expressed as percentages of the average prices for the years 1867–77:—

English Wheat . . . 60	Beef, prime . . . 88	West Indian and Beet
American Wheat . . . 62	Beef, middling . . . 88	Sugar, average . . . 59
Flour 63	Mutton, prime . . . 89	Java Sugar 62
Barley 77	Mutton, middling . . . 85	Coffee, Plantation and
Oats 79	Pork 87	Rio, average 65
Maize 71	Bacon 92	Tea 64
Potatoes 64	Butter 89	
Rice 70		
Total for group . . 546	Total for group . . 618	Total for group . . 250
Pig-iron 60	Cotton, Uplands . . . 62	Hides, average of river
Iron bars 59	Cotton, Dhollerah . . 63	Plate, dry and salted, 95
Copper 57	Flax 73	Leather Crop hides . . 94
Tin 83	Hemp 82	Tallow 76
Lead 57	Jute 63	Palm Oil 77
Coals, London . . . 75	Wool, Foreign . . . 73	Olive Oil 78
Coals, export . . . 72	Wool, English . . . 50	Linseed Oil and Seeds, 73
	Silk 55	Petroleum 55
		Soda Crystals 60
		Nitrate of Soda . . . 75
		Indigo 72
		Timber 81
Total for group . . 463	Total for group . . 521	Total for group . . 836

Grand Total 3,234

Index Number = $\frac{3,234}{45} = 72$

This Index Number has been calculated for every year from 1846. A similar number, based on a smaller number of commodities, has also been prepared by Mr. Sauerbeck back to 1818.

Exact Systems of Weighting.—When we pass from this rough method of weighting to a system based on the extent to which the commodities are consumed in unit time, we are confronted with a difficulty which has led to the two principal methods of weighting that have in practice been adopted. This difficulty lies in the fact that the relative importance of different commodities varies from year to year.

(1) *Fluctuating Weights Method of Drobisch.*—The earliest weighted Index Number known to me is that of Drobisch, who published in 1871 in the *Jahrbuch für Nationalökonomie* a paper entitled “Ueber die Berechnung der Veränderungen der Waarenpreise und des Geldwerths.” In this paper he advocates a weighted mean with what may be called fluctuating weights. He proposes to compare for two years the result of dividing the total value of certain articles dealt with in a particular market by the total mass of these articles in each year. This process has the merit of a certain simplicity. It will be seen that each article is not really weighted according to the extent

to which it enters into the national Expenditure; for, as noticed by Held,* the quantities of certain commodities dealt with in a particular market cannot be held to represent the relative quantities of these commodities actually available for consumption in the district supplied by the market.

Method of Mr. Palgrave.—Mr. R. I. Palgrave, in an appendix to the third report of the Royal Commission on Depression of Trade, gives an Index Number with similarly fluctuating weights; but the weights are based directly on an estimate of the value of the commodity used up per annum (production + imports — exports). A commodity re-exported in another form is held to be used up in the country. His formula differs from that of Drobisch, as, instead of taking for each year the price per ton of each article and multiplying by the tons consumed, he takes the ratio of the prices in the two years and multiplies by the values consumed in the second. In spite, however, of differences in procedure, the principle of using fluctuating weights is common to both these Index Numbers.

The obvious objection to this method is that (to take an extreme example) a mere change in the proportion of different articles consumed, without any alteration in the price of any of them, will lead to an alteration in the Index Number. This objection was made by Laspeyres; but it may perhaps be plausibly argued that a change in the proportionate consumption of certain commodities, more expensive ones being substituted for less expensive, represents a change in the cost of normal living, and should be reflected by a change in the Index Number. On the other hand, two considerations must be borne in mind. First, that the interpretation of this Index Number, when we have got it, is somewhat complicated. Drobisch's Number, for example, as it stands, gives a direct measure of the price of a fixed weight, made up of raw materials in the proportion in which these are dealt in during the year. When, however, we consider that the raw materials are used merely as types and that the Number is supposed to be an Index of the change in general prices (it being, as pointed out above, impossible to construct a complete Consumption Index Number), its interpretation certainly almost eludes the grasp. In the second place, on whatever figures our estimates of consumption are based, a single year would seem to be too short a period to argue from, especially as it leaves out of count all questions of stocks. It is, I should say, essential that the estimate of amounts consumed should extend over a period considerably greater

* In a paper in the same *Jahrbuch*, entitled "Noch einmal über der Preis des Geldes."

than that of the interval between two successive calculations of the Index Number.

(2) *Fixed Weights. Method of Mr. Ellis.*—The second of the principal methods of weighting is, of course, that of taking fixed weights, derived either from an average of years or from a particular year. In the earliest English weighted Index Number of which I can find any trace, the latter method was adopted. The method of construction is contained in a paper by Mr. Arthur Ellis, published as a supplement to the *Statist* of June 8, 1878. Mr. Ellis was evidently unacquainted with the work of Drobisch, as he speaks of his own number as being the first attempt at a scientifically weighted Index Number. He writes:—

“The difference between the plan we pursue and others that have been tried is that we take for basis the ascertained relative importance of the articles in a certain large division of trade instead of assigning a more or less arbitrary value to each article and group of articles.”

In his calculation he takes 1869 for the standard year both for prices and for relative weights. An Index Number constructed on this principle is at least capable of interpretation; for it measures the change in the amount of money that would have to be paid for certain articles, these articles representing, as nearly as possible, the national consumption in a certain mean year.

If the items of national consumption may be supposed to remain practically constant over a period of years, this method is a good one, so far as this period extends. But it is not fitted, without alteration, to comparisons over a considerable period of time. Professor Marshall, in an article in the *Contemporary Review* for March, 1887, recommends that each year should only be compared with the preceding one, the average of the consumption for the two years being taken for the weights. This would be an excellent method if really trustworthy estimates of consumption could be formed for each year, but this is practically impossible. Probably the best way of meeting the difficulty is to recalculate the weights from time to time, and, when doing so, to calculate Index Numbers for a few years on both systems of weighting.

It would then be possible to trace back general changes in prices over the whole series of years dealt with. For how long a period one series of weights may be considered as holding good depends, of course, upon the nature of the economic history of the period under review. A period of rapid economic change would demand a frequent revision of the weighting.

A question suggested by the scheme recommended by the British

Association Committee has already been touched on. In submitting the scheme, no mention is made of the methods adopted for arriving at the estimated expenditure per annum on each article; but it is stated that "allowance is made for the addition to the value made before the articles are in the form in which they are finally consumed." Apart from the theoretical objections, already adduced, to this procedure, which, as far as I know, has never been actually adopted in practice, it is not stated how this estimated addition was arrived at.

As regards the practical question of how best to estimate the proportions in which articles enter into the National Consumption, I think that a good foundation may be found in the Memorandum, by Mr. R. L. Nash, attached to the numbers published by Mr. Palgrave. In many cases he has been compelled to take a rough estimate for the National Production and to consider this constant throughout the period under discussion.

To such a list of commodities as that of Mr. Sauerbeck or the Committee of the British Association it seems to be desirable to add some figures with regard to bricks, although it may be difficult to obtain very trustworthy price figures with regard to these.

Sources of Price Quotations.—As regards the sources of prices, there are for the majority of commodities only two available sources; namely, market quotations and declared values in Foreign Trade. Jevons, Mr. Sauerbeck, and others adopted the former method, and based their price fluctuations on market prices taken at intervals throughout the year. Mr. Ellis, on the other hand, has adopted the method of declared values.* He points out that in the method of Jevons it is often necessary to take the average at the highest and lowest quotations, and consider this as the price of a medium quality, whereas in the method of declared values we at least ascertain what is actually paid for cotton, and the change in this is probably a better measure of the change in prices, as a whole, than would be a measure obtained from the consideration of only one quality.

Foreign Trade Statistics.—The statistics of Foreign Trade were also made use of in the Index Number of Soetbeer. This number was based originally on one hundred articles, and the prices used were declared values at Hamburg (which throughout the period considered remained a free port), except in the case of beef, veal, mutton, and eggs, for which the prices paid by the Hamburg government were substituted. These articles were arranged in seven groups, and an unweighted Index Number obtained for each group as well as for

* This is, of course, also true of the Foreign Trade Index Numbers, which are referred to on page 441 below.

the whole. To these was subsequently added an eighth group of articles of British export, the prices of the fourteen articles included being the British declared values.

Objection to Use of Market Prices for Seasonal Articles.—The inclusion of a commodity such as eggs, whose price is largely governed by seasonal considerations, suggests a criticism made by Professor Marshall in the article in the *Contemporary Review* already referred to. He argues that, if market prices are taken, then, in the case of its becoming possible to obtain a commodity at times (strawberries) or places (fish) where formerly it was impossible, the average price over all these times or places may appear higher when really the change has increased the purchasing power of money. It is obvious that by choosing declared values we escape this criticism to a great degree. The difficulty of allowing for a change of quality over a long period of years does not appear to me to affect the method of declared values to a much greater extent than the other, the necessity above referred to for taking the mean of the highest and lowest prices introducing an error at least comparable to that due to several varieties being included under one head in the Foreign Trade Returns.

Certainly, for the purpose of an official Index Number there seems in the absence of official market prices, such as the *Gazette* averages for corn, to be no question as to the more advisable method. I may state that, in the case of almost every commodity, the British Association Committee recommend a price based on declared values. I propose, therefore, to adopt either import or export values, according as the article is chiefly one of import or export, except in the following cases: (1) British corn, where the *Gazette* prices are made use of, import values being retained in the case of foreign corn; (2) milk and potatoes, where I have made use of the records of prices paid by certain hospitals; (3) beef and mutton, where I have had to fall back on the average prices of live meat (sinking the offal) at the Metropolitan Cattle Market, as given in the Annual Returns of the Board of Agriculture, making use in each year of the prices quoted for best British beef and mutton; (4) bricks, where a return of the price of bricks at Glasgow, specially contributed by the Glasgow Master Brickmakers' Association, has been made use of. In the case of fish the official value of fish landed would have been employed if the figures had been collected throughout the period for which the Index Number has been calculated. As this is, unfortunately, not the case, I have fallen back upon the declared export values of herrings in barrel.

Two Possible Formulas.—Another point in the consideration of a

Consumption Index Number is the choice of formula to be employed. It being supposed that some system of fixed weights is to be adopted, two possible formulas naturally suggest themselves. I give both:—

First—

$$\text{Index Number} = \left[\frac{\text{Price of article A in a given year} \times \text{standard weight}}{\text{Price at standard period}} + \frac{\text{Price of article B} \times \text{standard weight}}{\text{Price at standard period}} + \text{etc.} \right] \div [\text{Sum of standard weights.}]$$

Second—

$$\text{Index Number} = [\text{Price of article A} \times \text{standard weight} + \text{price of article B} \times \text{standard weight} + \text{etc.}] \div [\text{Standard price of article A} \times \text{standard weight} + \text{standard price of article B} \times \text{standard weight} + \text{etc.}]$$

The first formula presents the solution as a method of averaging price changes. The second gives a comparison of the total expenditure on certain commodities at different periods. Perhaps the latter is, on the whole, rather more objective in its nature; but it will be observed that in this case the prices will all have to be stated as the price paid for a certain definite mass, say, a hundred-weight, which must remain the same throughout, and the “weights” will be the actual mass of each commodity consumed. For the purposes of the first formula the weights used will most conveniently be the *values* of the different articles consumed. This formula has the merit of showing at a glance to what extent the price variations of particular commodities or particular groups of commodities conform to the variations in the total Index Number. This is especially the case, if it is considered desirable to arrange the commodities in groups, and to evaluate an Index Number for each group, as is done, for instance, by Soetbeer.

In view of the interest of such group numbers, I am inclined to give the preference to the first formula as, perhaps, on the whole, superior in use to the second, and it has been adopted in the construction of the Index Number given on page xxxiv. The results are hardly likely to differ much, whichever of the methods is employed.

In the Index Numbers given in Table 1 the articles are for convenience arranged in seven groups, for each of which the Index Number is calculated separately.

Special Index Numbers.—It should, however, be at once stated that any such Special Index Numbers can only be employed with great caution. If, for instance, we are considering the needs of a particu-

lar class, it cannot be assumed that a portion of the Index Number can be, as it were, detached and made applicable to them. The weight given for the consumption of coal in Table 2, for instance, necessarily covers all the different uses to which it is put, and differs from the weight which would be accorded to it if we were considering only its use by the individual consumer for fuel. Few raw commodities can be allocated to a more than partial extent to any one special group of wants they are used to satisfy. Even wheat flour is used to some extent for other purposes than as a foodstuff.

Standards Other than the Consumption Standard.—Up to the present I have made no direct reference to standards other than the consumption standard. For the sake of completeness, however, I should say, that it has been proposed to compare the change of value, over a long period, of the articles in existence at each period, instead of the changes in the values consumed in unit time. The method employed need not here be further discussed, as it does not lend itself to the yearly publication of an Index Number. Another suggestion is that the importance of a change in prices being not merely its effect on the consumer, but its effect on the business man, its measurement should not be based on the extent to which commodities enter into the National Consumption, but rather on the frequency with which they change hands. From this point of view the standard should include all vendible articles whatsoever; *e.g.*, Pig-iron, Manufactured Iron, Steel and Machinery, should all find places according to their values, for at each change, at least, in their form from raw materials to finished articles they are likely to change hands.

Foreign Trade Index Numbers.—The Index Numbers based on Foreign Trade to some extent answer to this description, if we may assume Foreign Trade to be typical of the whole of Trade.

Sir R. Giffen's Index Numbers.—Such Index Numbers were constructed for the Import and Export Trade of the United Kingdom separately by Sir Robert Giffen in his reports on Prices of Exports (1878) and Prices of Imports and Exports (1879, 1880, 1881, 1885, and 1888). The object of these reports was the perfectly definite one of obtaining a measure of the fluctuations in the volume of both branches of Foreign Trade independent of the fluctuations in prices of the commodities involved. The relative weights of the various commodities are worked out for a series of years, but only one of the systems of weights was in practice taken for the evaluation of the Index Number, it being found that the various systems gave practically identical results.

In the published numbers some confusion appears to me to be

introduced by the choice of standards adopted. Instead of 100 being taken as the Index Number in the standard year for both groups, 65.8 is taken as that for exports, and 81.6 for imports, these being the actual percentage proportions which the values of the commodities used in the preparation of the numbers (namely, those for which both quantities and values are given in the returns) bear to the total value of the Imports or Exports. There was, perhaps, at the time of publication of these reports, when the idea of an Index Number was still comparatively novel, something to be said for continually keeping before the mind's eye the fact that the commodities used were samples of, but did not amount to the whole of the Foreign Trade. But this consideration has now lost much of its force.

Meaning to be given to Consumption.—It must be remembered that in the construction of a Consumption Index Number we do not keep in view only the wants of the individual user, who actually eats the food, wears out the clothes, and so on. Such an interpretation of the word "consumption" has, so far as I know, never been adopted. For the purpose of Index Numbers, and in the preparation of the particular one which is now about to be dealt with, consumption is taken to mean any process by which the commodity is substantially changed in character. The cotton, for instance, which is imported and afterwards re-exported as piece goods is taken as consumed, whilst the tea which is imported and afterwards re-exported in practically the same form is taken as not consumed in the United Kingdom. In other words, consumption in manufacture is recognized as well as consumption by an individual. If we attempted to estimate the amount of cotton actually used up by the private person within this country, and so on for the various other raw materials, we should be confronted with problems in detail presenting hardly any hope of an even approximately accurate solution.

I now proceed to the computation of an Index Number on the general lines that I have sketched out. The result of this computation is shown in Table 1 on page xxxiv. On comparing this number with that of Mr. Sauerbeck, given on page 451, it will be noticed that the fall in prices between 1871 and 1896 (when the lowest figure was reached) is considerably less than that shown by Mr. Sauerbeck, being only 30.2 as against 39 per cent. On examining further, however, it will be seen that as between 1874 and 1896 the amount of fall shown by the two numbers is very similar, being from 113.6 to 69.8, or about 39 per cent. in the one case, and from 102 to 61, or about 40 per cent. in the other. And in general from 1874 onwards

the two numbers march on nearly parallel lines. I have elsewhere pointed out* that the years 1871-73 were exceptional in character, and that, if Mr. Sauerbeck's price changes be weighted, as are those in the Index Number now to be computed, the fall between 1871 and 1896 would have been shown as about 35 instead of 39 per cent. In other words, the difference of weighting accounts for nearly half the difference between the two results. Further, there is an intelligible reason why, in the years 1871-73, the prices I have made use of should be generally relatively lower than those used by Mr. Sauerbeck. Contract prices for the whole year have been employed in the case of two important articles,—milk and potatoes,—and declared values in most other cases. It may well be supposed that in the case of a sudden and violent rise in prices, following on a period of gradual decline, neither of these two classes of price quotation would show quite the same amount of rise as would the actual prices of raw commodities in the market on which Mr. Sauerbeck has based his Index Number.

* See Note B, pp. 448, 449.